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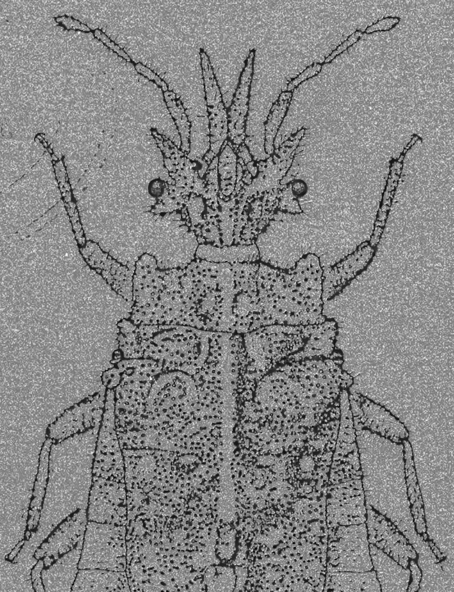

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Cover: *Granulaptera cooki* Monteith (Hemiptera: Aradidae) is one of many wingless species of bark bugs found in the rainforests of the Wet Tropics of northern Queensland. This species is generally restricted to high altitudes in the northern Wet Tropics and is most common on Mt Finnigan. Illustration by Geoff Thompson.

AN ANNOTATED LIST OF THE HAWK MOTHS AND BUTTERFLIES (LEPIDOPTERA) OF LIZARD ISLAND, QUEENSLAND

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Entomology Department, Australian Museum, 6 College St, Sydney, NSW 2010

Abstract

Records are provided for 19 species of hawk moths and 23 species of butterflies from Lizard Island, northern Queensland. Notes are given on abundance.

Introduction

The hawk moths and butterflies of Lizard Island are poorly documented compared with nearby Queensland coastal regions. Moulds (1985) recorded two species of *Macroglossum* Scopoli, *M. micaceum micaceum* (Walker) and *M. prometheus lineatum* (Lucas) from the island but D'Abrera (1987) did not list it as a specific locality for any Australian species. Duckworth and McLean (1986) listed 11 species of butterflies from the island.

Lizard Island (14°40'S, 145°28'E) lies approximately 27 km off the north Queensland coast, about 93 km NNE of Cooktown. It is a dry island with large areas of bare, exfoliating granite cliffs and hills. Around 60% of the island is covered by grassland. Eucalypt and acacia woodlands are found in some areas along with mangroves (3 species) fringing some beaches. Paperbarks and pandanus are found in an area behind Watsons Bay. The island is about 4 km long from north to south, about 3 km wide at its widest point and has an area of close to 10 km^2.

This survey was carried out between 30 November and 13 December 2002. Conditions were extremely dry and no rain of note had been recorded since the previous January. Fortunately, about 30 mm of rain fell on the first night of the survey but no further rain was recorded during the survey period.

All specimens are in the collection of RBL temporarily; duplicates are held by the Queensland Museum, Brisbane and the Australian National Insect Collection, CSIRO, Canberra.

Discussion

Eighteen species of hawk moths and 19 species of butterflies were collected during the survey. They are listed in Table 1, together with notes on abundance. The severe drought affecting Lizard Island clearly reduced the numbers of both groups, both in terms of species and general abundance. This appeared to be particularly the case with butterflies, with only well known species being encountered. The possible exception is *Taractrocera ina* Waterhouse, noted by Braby (2000) to have a sporadic distribution along the eastern coast of Cape York Peninsula. A return to normal rainfall patterns (approximately 1300 mm p.a.) should see an increase in both species and numbers of both groups.

Table 1. List of hawk moths and butterflies collected on Lizard Island. An asterisk (*) indicates a previously recorded species and a double asterisk (**) a previous record that was not repeated in late 2002.

Species	Notes
HAWK MOTHS (19 species)	
Sphingidae	
Agrius convolvuli (Linnaeus)	Abundant
Leucomonia bethia (Kirby)	Abundant on some nights
Cephonodes janus janus (Miskin)	One female
Cephonodes picus (Cramer)	One female
Gnathothlibus erotus eras (Boisduval)	Abundant
Gnathothlibus sp. [undescribed]	Two males
Macroglossum corythus pylene (C. Felder)	Two males
Macroglossum hirundo errans (Walker)	21 males, no females
Macroglossum micaceum micaceum (Walker) *	One female
Macroglossum prometheus lineatum (Lucas) **	Moulds 1985
Macroglossum tenebrosum (Lucas)	One female
Hippotion celerio (Linnaeus)	One male
Hippotion velox (Fabricius)	One male, three females
Theretra clotho celata (Butler)	Abundant
Theretra indistincta (Butler)	Very common
Theretra inornata (Walker)	Very common
Theretra latreillii latreillii (W.S. Macleay)	One male
Theretra margarita (Kirby)	One female
Theretra silhetensis intersecta (Butler)	Four males, two females
BUTTERFLIES (23 species)	
Hesperiidae	
Taractrocera ina Waterhouse	
Telicota augias krefftii (W.J. Macleay)	
Cephrenes trichopepla (Lower)	
Papilionidae	
Papilo aegeus aegeus Donovan	
Papilo fuscus capaneus Westwood	A common species
Cressida cressida cressida (Fabricius)	
Pieridae	
Eurema hecabe hecabe (Linnaeus) *	Common

Elodina walkeri Butler	Fairly common
Belenois java teutonia (Fabricius)	Dark form, common
Cepora perimale scyllara (W.S. Macleay)	
Appias paulina ega (Boisduval)	
Nymphalidae	
Hypocysta adiante adiante (Hübner) *	
Hypolimnas bolina nerina (Linnaeus) *	
Tirumala hamata hamata (W.S. Macleay) **	Duckworth & McLean 1986
Danaus plexippus (Linnaeus)	
Euploea core corinna (W.S. Macleay) *	
Lycaenidae	
Arhopala centaurus centaurus (Fabricius)	A very common species
Hypolycaena phorbas phorbas (Fabricius) *	A very common species
Anthene seltuttus affinis (Waterhouse & R. Turner) *	
Candalides erinus erinus (Fabricius) *	
Theclinesthes sp. **	Duckworth & McLean 1986
Famegana alsulus alsulus (Herrich-Schäffer) **	Duckworth & McLean 1986
Euchrysops cnejus cnidus Waterhouse & Lyell **	Duckworth & McLean 1986

Acknowledgements

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BOOK REVIEW

A guide to the dragonflies of Borneo: their identification and biology. By A. G. Orr. Natural History Publications (Borneo), Kota Kinabalu, Sabah, Malaysia; January 2003; x + 195 pp; hardback. ISBN 983-812-069-3.

Tropical insect faunas have been poorly served by guidebooks, for many reasons. Dr Orr has now written one that provides an excellent model for authors in the future and odonatists are very fortunate to have such a beautiful book. With colour illustrations on almost every page, it is a pleasure to read and to browse. This book is a comprehensive guide to the known species of Borneo and their ecology. There are some 275 named species, 42% of them endemic, and over half of them are illustrated. There are parts of Borneo which have scarcely been explored for dragonflies and there must be a number of species awaiting discovery - this book provides a solid base from which to work.

Introductory chapters outline structure and biology, biogeography and ecology. There are useful hints on collecting, preserving and photography, plus descriptions of the major habitats with appropriate illustrations. A key to the families (adults) is accompanied by explicit diagrams and is followed by a complete checklist of species. Conservation is noted to be more apparent than real, since logging is allowed to go on in National Parks, but it is a start. Much remains to be done, hindered in part by the difficult terrain and lack of access. The most interesting and least known species inhabit montane rainforest - not the easiest place for collecting adults which may hunt at tree-top height, or are thinly scattered.

The main part of the book consists of species accounts arranged by family. Included here are details of life histories and habitat preferences, with advice on species identification. Where this is critical, pointers to the available literature are given. The author has extensive field experience and the accounts benefit greatly from this, being enlivened at times by personal anecdotes and observations. Of particular interest are the chlorocyphid damselflies, which use their spectacular colours to advantage in courtship displays, differing from species to species and comprising dancing, wing flashing and leg dangling (to show white 'gaiters'). Some males may only feed on alternate days. In the case of some Anisoptera, the female has a scoop-shaped tip to the abdomen, with which she collects a drop of water and flicks it, together with her eggs, onto terrestrial substrates such as overhanging leaves. These are just some of many fascinating insights into the life styles here presented.

The book is illustrated throughout with photographs, mostly taken by the author but with contributions from several others, especially M. Hämäläinen, which include close-ups and some larvae. To cap it all off, there is a magnificent portrait gallery of paintings by the author, on 25 plates, representing 115 species of adults and 18 species of larvae. This book will, I suspect, prove irresistible to dragonfly enthusiasts, whether amateur or professional, and will have an appeal far beyond its remit. It is highly recommended.

J. N. Yates
Imbil

THE INSECTS ASSOCIATED WITH GALLS FORMED BY *TRICHILOGASTER ACACIAELONGIFOLIAE* (FROGGATT) (HYMENOPTERA: PTEROMALIDAE) ON *ACACIA* SPECIES IN TASMANIA

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Abstract

Galls produced by *Trichilogaster acaciaelongifoliae* (Froggatt) were collected over several years from several phyllodinous species of *Acacia*, mainly *A. sophorae* and *A. stricta*, and the insects reared from them. The number of gall-forming adults and parasitoids reared from individual galls is compared with the size of the galls. The effect of galling on host plant health is commented on in relation to planting of these *Acacia* species in community or government funded projects. Twenty-one insect species were reared from galls formed by *Trichilogaster acaciaelongifoliae* on *Acacia* species in Tasmania.

Introduction

One of the 'classic' papers in Australian entomological literature is that of Noble (1940), in which he examined the biology of the pteromalid *Trichilogaster acaciaelongifoliae* (Froggatt) and showed that this species was responsible for gall formation on a number of phyllodinous wattle species in the Sydney area, New South Wales. In recent times some of those wattle species have been introduced to South Africa, in particular *Acacia longifolia* (Andr.) Willd., which has become an invasive weed (Boucher and Stirton 1978). A program of biological control of *A. longifolia* has commenced with the release (Dennill 1987) of *T. acaciaelongifoliae*, the aim being to reduce seed production and vegetative growth (Dennill 1985).

In Tasmania, phyllodinous wattles are widely planted in coastal reserves and town park areas as they are fast growing and require little maintenance once established. The presence of large numbers of galls results in the decline in health of wattles in planting projects. The visual result is unsightly and replanting is required after several years. It is recommended that community funded revegetation projects plant *Acacia* species less susceptible to galling by *T. acaciaelongifoliae*.

Methods

Galls were collected from three coastal amenity plantings of *Acacia sophorae* (Labill.) R. Br. ex Ait. (Boobyalla or Coast Wattle) and *A. stricta* (Andr.) Willd. (Hop Wattle) on an opportunistic basis. Regular collections were made from two large, heavily galled *A. sophorae* shrubs planted in 1990, spaced 500 m apart, in a fire rehabilitation planting at Bell Bay in northern Tasmania. Collections were made every two weeks during the life of the galls, from late October 1999 to the end of May 2001 and some dead galls were collected to identify some inquiline species. Voucher specimens are deposited in the Tasmanian Forest Insect Collection, Hobart.

Mass groups of galls were placed in 19 cm diameter glass petri dishes and emerging insects removed weekly. Individual galls were held in plastic food containers with perforated lids to prevent build up of condensation. All galls were weighed within 6 hours of collection, either in mass groups or individually, after being transported in sealed paper bags. All galls were held in a controlled temperature room at 18°C. Humidity in the glass dishes was 70% RH when containing green galls, declining to 40% RH when containing old dry brown galls.

Galls from two northern and one southern site were divided into three size classes (<20 mm, 20-30 mm and >30 mm diameter). Volumes and weights of the gall groups were calculated and the galls retained for insect emergence. Analysis of variance was used to determine differences between emergence and gall size and sites and gall size at the 95% confidence level.

Table 1. The insects reared from galls formed by *T. acaciaelongifoliae* on *Acacia sophorae* in Tasmania.

Insect species	Family	Number of specimens
Hymenoptera		
Trichilogaster acaciaelongifoliae (Froggatt)	Pteromalidae	1865
Poecilocryptus nigromaculatus Cameron	Ichneumonidae	118
Eriostethus sp.	Braconidae	11
Megastigmus ?darlingi	Torymidae	45
Megastigmus sp.	Torymidae	19
Eurytoma gahani Noble	Eurytomidae	105
Glabridorsum stokesii (Cameron)	Ichneumonidae	1
Chromeurytoma noblei (Girault)	Pteromalidae	395
Ormyromorpha sp.	Pteromalidae	1
Coelocyba nigrocincta Ashmead	Pteromalidae	1
Sierola sp.	Bethylidae	1
Coleoptera		
Araecerus palmaris (Pascoe)	Anthribidae	1240
Eleale sp.	Cleridae	27
Lepidoptera		
Polysoma eumetalla (Meyrick)	Gracillariidae	167
Erechthias mustacinella (Walker)	Tineidae	108
Stathmopoda cephalaea Meyrick	Oecophoridae	14
Holocola (Eucosma) triangulana Meyrick	Tortricidae	89
Macrobathra sp.	Cosmopterigidae	22
Gauna aegusalis (Walker)	Pyralidae	5
Opogona comptella (Walker)	Tineidae	1
Hemiptera		
Nipaecoccus ericicola (Maskell)	Pseudococcidae	

Results

A list of the insects associated with galls collected from *Acacia sophorae* bushes at coastal amenity plantings on the east and north coasts of Tasmania is presented in Table 1. Emergence patterns over a two-year period for all species emerging from *T. acaciaelongifoliae* galls are shown in Fig. 1.

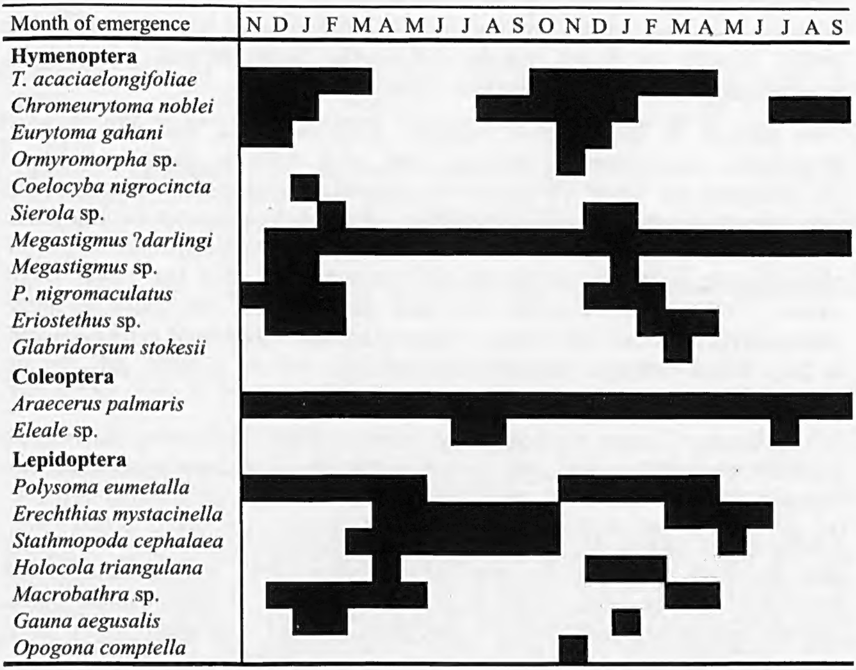

Fig. 1. Emergence periods of insect species recorded from *Trichilogaster acaciaelongifoliae* galling on *Acacia sophorae* in Tasmania.

Notes on insect species utilising *T. acaciaelongifoliae* galls

The primary gall former, *T. acaciaelongifoliae*, emerged from late November to early April at northern Tasmanian sites and between late December and early March at southern Tasmanian sites (Fig. 1). Sex ratio was 0.48:1.0 (606 males, 1259 females).

The ichneumonid *Glabridorsum stokesii* is a generalist parasitoid of Lepidoptera species. The other ichneumonid, *Poecilocryptus nigromaculatus*, was a common species at all sites (56 males, 62 females). This species was found to prey indiscriminately on the primary gall former and associated parasitoids in galls on *Melaleuca* produced by fergusoninid flies (Goolsby *et al.* 2001). It is suprising that this species was not recorded from *Uromycladium* galls at the same sites (Bashford 2002).

The chalcid wasps are all parasitoids or predators of the primary gall former and, in some cases, hyperparasitoids. *Eurytoma gahani* and *Chromeurytoma noblei* were common emergents from galls at most sites. *C. noblei* emerged in greater numbers but from fewer galls than *E. gahani*. *E. gahani* and *Coelocyba nigrocincta* larvae appear to feed phytophagously within the cell occupied by the developing gall former larva until the final instar. On attaining this stage of development the gall former larva is devoured (Noble 1940). It may be some months before the larva pupates in order to synchronize with new gall formation. (Noble 1939a).

Two species of *Megastigmus* emerged from the galls, one with a long ovipositor, *Megastigmus ?darlingi* and one with a short ovipositor, *Megastigmus* sp. Some species of *Megastigmus*, for example *M. acaciae*, are internal larval parasitoids (Noble 1939b), while others appear to be inquilines feeding on gall tissue (Currie 1937). The short ovipositor species may feed phytophagously before killing the gall former larva at a late instar stage (Noble 1939b). *M. ?darlingi* emerged mainly from old galls in July-September with some individuals emerging in November from galls collected in July. Combined species parasitism/predation of the primary gall former from all sites was 45.5%.

All Lepidoptera emerging from *T. acaciaelongifoliae* galls were also reared from *Uromycladium* rust galls on *Acacia dealbata* in a previous study by Bashford (2002).

Adults of the weevil *Araecerus palmaris* were found sheltering in old open galls for most months of the year; often several adults were present in the same gall. Larvae were found in 36% of galls of an intermediate stage between mature soft green and old hard galls. The sex ratio was 0.86:1.0 (573 males, 667 females). A similar sex ratio (0.88:1.0, n=95) was recorded from *Uromycladium* galls on *Acacia dealbata* by Bashford (2002). Noble (1941) noted the emergence of *A. palmaris* (as *Doticus pestilens)* from galls on *A. decurrens* caused by *Trichilogaster maideni* (Froggatt).

Emergence from individual galls

There was no significant difference in the number of *T. acaciaelongifoliae* adults emerging from the different sized gall classes ($F=2.36731$, $P<0.05$, $n=100$ galls for each size class). The same applied to the proportions of emerging parasitoids (Table 2). Smaller galls tended to have higher levels of parasitism but this was not statistically significant. Larger galls did not necessarily produce a greater number of gall formers than smaller galls. However the number of external lobes on a gall determined the number of chambers each formed by a *T. acaciaelongifoliae* larva. The number of lobes on 67 large green galls greater than 30 mm diameter were counted along with the number of primary exit holes formed by *T. acaciaelongifoliae* and their relationship shown in Table 3.

Table 2. Proportion of known *T. acaciaelongifoliae* parasitoids emerging from galls of three size classes. Ten galls in each gall diameter class from each site.

Site	Galls <20 mm diameter Parasitoids	%	Galls 20-30 mm diameter Parasitoids	%	Galls >30 mm diameter Parasitoids	%
Bell Bay	29	54	26	34	17	41
Lauriston	23	61	31	13	24	21
Blackmans Bay	22	29	39	15	12	13
Total	**74**	**48**	**96**	**21**	**53**	**25**

Table 3. Relationship betwen the number of gall lobes and emerging *T. acaciaelongifoliae* adults.

	Number of lobes per gall 1	2	3	4	5
Number of galls	16	22	22	6	1
Number of *T. acaciaelongifoliae*	24	47	61	24	4
Average per gall lobe	1.5	1.07	0.92	1	0.8

Impact of galling on plants

Galls first appeared on *A. sophorae* plants at Bell Bay in early July with galls 1-2 mm in diameter at inflorescence sites. Green galls 5 mm in diameter were infesting all lower branches of shrubs 2-3 m in height a month later (Fig 2a). In early January maximum gall development was achieved; their average weight and volume are recorded in Table 4. By early March many galls were turning brown (Fig. 2b) and starting to break down following the completion of emergence of the primary gall former and associated insects. A small proportion of galls (<3%) persist as green, fleshy, small galls until June but they seldom had exit holes. This may be a result of natural mortality of the gall former at an early stage of development.

Table 4. Average weight and volume of *T. acaciaelongifoliae* galls within each diameter class. Figures in italics indicate percentage of galls in each diameter class at each site. No significant difference was observed between diameter classes and sites (F=1.06008, P=<0.5, n=90).

Site	Galls <20 mm diameter Weight (g)	Volume (mm^3)	%	Galls 20-30 mm diam. Weight (g)	Volume (mm^3)	%	Galls >30 mm diameter Weight (g)	Volume (mm^3)	%
Bell Bay	3.35	2848.8	*18.3*	7.16	6182.3	*57.6*	9.17	12012.8	*24.1*
Lauriston	3.54	2848.8	*8.9*	7.33	7424.1	*48.6*	12.52	12373.8	*42.5*
Blackmans Bay	2.9	2815	*15.4*	7.13	7367.8	*61.8*	8.99	9907.2	*22.8*

On infested trees very few inflorescences made the transition to flowers and seed-pods were rare on these plants. Seed production is greatly reduced by the galling of reproductive buds. The heavy aggregations of multi-celled galls on stems prevented stem elongation and patches of dying branches were evident in February on large bushes. Young shrubs did put on shoot growth in March and April when most galls were brown. The impact on larger shrubs over 3 m high was more evident with sections of the shrubs dying. The rate of phyllode abscission increased making the shrubs thin crowned and patchy. Most plants can survive a number of years of heavy gall infestations but become unsightly with branch breakage common in the winter.

Discussion

The use of fast growing *Acacia* species for amenity plantings in coastal areas of Tasmania has been encouraged by community funding programs administered by organisations such as Landcare, Greening Australia and local councils. Considerable community work goes into the initial planting and establishment phases of these programs and it is disappointing to see some plantings in decline due to biotic effects such as galling, largely due to the choice of tree species planted. Alternative *Acacia* shrub species for planting in coastal areas are Varnish wattle (*Acacia verniciflua*), Wirilda (*Acacia retinodes*) or West Australian golden wattle (*Acacia saligna*). None of these species was galled although all were present in the plantings at Bell Bay.

Dennill *et al.* (1993) records *T. acaciaelongifoliae* as forming galls on Blackwood (*Acacia melanoxylon* R. Br.) in South Africa. This species is a valuable furniture and veneer timber grown in managed native forest stands and plantations in Tasmania. In South Africa, 10% of Blackwood trees surveyed carried galls although the size and number of galls per branch were much reduced compared to other *Acacia* species examined. In Tasmania, galling of Blackwood has not been observed. The Blackwood plantation estate in Tasmania is routinely monitored by Forest Health officers for pests and diseases. Blackwoods at the Bell Bay study site were not infested. It would seem unlikely that galls caused by *T. acaciaelongifoliae* will be a threat to the expanding Blackwood plantation estate in Tasmania.

In South Africa, *T. acaciaelongifoliae* has been introduced as a gall-forming biological control agent of *Acacia longifolia* (Dennill 1987). Several native parasitic species have been found to be associated with it, causing up to 21.3% mortality (average 14.5% in four sites). In Tasmania, mortality levels averaged 45.5% but ranged from 12-61% with some differences observed in different gall size classes (Table 2). The impact of host mortality on gall formation and subsequent branch dieback appears minimal given the fecundity of the female gall former who can lay up to 400 eggs in the flower and vegetative buds of the host plant (Manongi and Hoffmann 1995). In Tasmania it is clear that parasitism rates have little impact on the number of galls developing and subsequent impact on tree viability.

Fig. 2. Impact of *Trichilogaster acaciaelongifoliae* galling on *Acacia sophorae* in Tasmania: (a) new and old galls on growing shoot; (b) heavy gall infestation on mature bush; (c) early stages of branch dieback on heavily galled bush.

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NOTES ON THE BIOLOGY AND DISTRIBUTION OF *TRAPEZITES TAORI* ATKINS (LEPIDOPTERA: HESPERIIDAE)

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Abstract

Trapezites taori Atkins is recorded breeding on *Lomandra confertifolia pallida* A.T. Lee (Xanthorrhoeaceae) growing along sandstone cliffs and escarpments at Blackdown Tableland National Park and at a new southern location for the butterfly in Carnarvon Gorge National Park, Queensland. A description is given of the previously unknown pupa and comments are made on the apparent close association between *T. taori,* its foodplant and the sandstone habitat of central Queensland.

Introduction

Trapezites taori Atkins was described from a series of both sexes collected at Blackdown Tableland and a single female from Isla Gorge, central Queensland (Atkins 1997). Eggs were obtained from captive females, enabling descriptions of early immature stages, but rearing beyond larval stage was not achieved (Atkins 1997). The captive larvae fed on several *Lomandra* spp. but immature stages were not located in the field.

T. taori has a limited distribution with adults regarded as rare (Atkins 1997, Braby 2000) and National Parks staff in the areas where the skipper was known to occur were keen to develop conservation management plans for it. We undertook work on the biology and distribution of *T. taori* in order to provide data on which to formulate conservation plans and the preliminary findings of these studies are presented here.

Life history and habitat

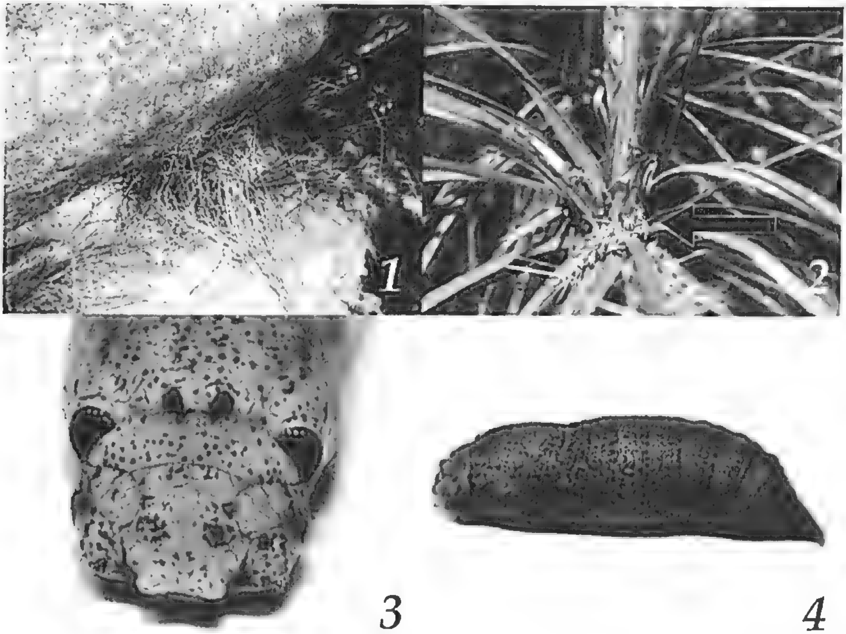
Adult males were observed in September and October 2000 at Blackdown Tableland, establishing leks in small clearings close to the edge of the sandstone escarpment, where they settled on low bushes, twigs or directly on the sandstone where the underside colour provided excellent crypsis. A male was subsequently observed patrolling a lek close to the base of the cliff in March 2003. On two occasions adults were observed to enter the area along the top of the escarpment by flying up the face of the escarpment. We could find no larvae or evidence of larval feeding on any of the several *Lomandra* spp. that grew in the heath or forest areas on the adjacent tableland.

In February 2001, we searched the broken edge along the top of the escarpment and located numerous fine-leaved *Lomandra* plants. A small, unidentified *Trapezites* Hübner larva was found in a curled dead leaf within one of the plants. The following day we searched down to the base of the cliffs and found the same *Lomandra* species growing commonly in cracks, along ledges and in the broken scree at the base.

Several final instar larvae fitting the description of *T. taori* and numerous earlier instar larvae similar to the one found the previous day were found on these plants. The larvae were taken to Townsville for closer examination and all were consistent with the published description of *T. taori* larvae. The plants were subsequently identified as *Lomandra confertifolia pallida* A.T. Lee (Xanthorrhoeaceae) by the Queensland Herbarium.

The larvae were placed on potted *Lomandra* plants in Townsville. Final instar larvae pupated and emerged in March and April but the earlier instar larvae continued to feed and emerged in August and September.

In this habitat, *L .c. pallida* differs from other *Lomandra* spp. in having long, very fine leaves growing from elongated stems with the dead foliage recurved against the stem to form dense clumps. The plants were restricted to exposed sandstone areas such as ledges (Fig. 1), cracks and crevices in the vertical walls, in the broken scree at the base of the cliffs and occasionally extending down water lines.



Figs 1-4. Host plant and pupa of *Trapezites taori*. (1) typical *Lomandra confertifolia pallida* host plant in crevice at Blackdown Tableland; (2) mature larval head of *T. taori* (arrowed) and seed capsules of host plant at Carnarvon Gorge; (3) pupa, anterior view; (4) pupa, lateral view.

Figs 5-6. Habitat of *Trapezites taori*. (5) Precipice sandstone formation at Blackdown Tableland; (6) *L. c. pallida* host plant on ledge at Carnarvon Gorge.

All areas that contained *L. c. pallida* appeared to be protected from fires and the plants were absent from sections of the escarpment where adjacent forest and grasses grew close to the exposed cliff and allowed fire to penetrate.

Early instar larvae sheltered between leaves of the food plant. Later instars commonly constructed elongated shelters in the recurved dead leaves, with the entrance of the shelter opening at the base of the growing leaves and flower spikes, or made shelters in leaf litter where available. In the absence of fires the dead foliage remained in place for long periods and final instar larval and pupal shelters from previous generations were commonly encountered.

L. c. pallida produces short flower spikes that give rise to 3-4 large seeds that lie at the base of the growing leaves. Each seed has a striped pattern similar to that of the later instar larval heads of *T. taori.* In instances where the later larval shelter was constructed with the opening at the level of the seeds, the mature larvae rested with the head fully exposed and blocking the entrance to the shelter (Fig. 2) and the exposed head capsule was often difficult to distinguish from the seeds of the plant.

The previously undescribed pupa of *T. taori* (Figs 3-4) is 23-27 mm long and cylindrical, tapering posteriorly to an elongate decurved cremaster. It is pale grey-brown covered with black spots and blotches. The frons has two raised areas centrally and dorsally, the latter overlaid with black blotches. A transverse black line lies across the frons at the base of the central raised areas. The prothoracic plates are black and black spots form broken transverse lines on the posterior of the abdominal segments. The cremaster is dark brown with a deep pit ventrolaterally at the junction with the final abdominal segment. Prominent black stripes overly the antennal clubs ventrally.

Discussion

We visited Carnarvon Gorge, Isla Gorge and Blackdown Tableland in late August 2002 to search for additional locations for *T. taori.*

At Carnarvon Gorge our searches were confined to the bottom of the gorges. *L. c. pallida* was found predominantly along the scree slope but occasionally on ledges (Fig. 6) and cracks in the cliffs. Larvae of *T. taori* were found throughout the gorges of Carnarvon Creek and its tributaries. *L. c. pallida* at Carnarvon Gorge was morphologically different from that occurring at Blackdown Tableland and Isla Gorge in having broader leaves and shorter stems.

The habitat at Carnarvon Gorge is much wetter than either Blackdown Tableland or Isla Gorge and the scree at the base of the cliffs is deep sandy soil that supports tall forest but few understorey plants. The *Lomandra* plants were restricted to the exposed cliffs and the steep scree close to the base of the cliffs and did not extend into areas supporting grasses that carried

frequent fires. The overlying forest produced deep leaf litter and later instar larvae commonly made shelters in fallen leaves. Occasional larvae of *T. eliena* (Hewitson) were also found on *L. c. pallida* at Carnarvon Gorge.

At Isla Gorge almost all the accessible *L. c. pallida* plants had been burnt in September 2001 and only a single larva of *T. eliena* was found on a regrowth plant.

At Blackdown Tableland, larvae were found in the same situations as in summer. Several later larval instar shelters contained pupal exuviae of ichneumonid wasps. Larvae from both locations were placed on potted plants in Townsville and produced adults in September, October, November, December and January.

The high numbers of larvae found at Carnarvon Gorge and Blackdown Tableland suggest that the species is likely to be more abundant than previously thought.

The underside colour of adult *T. taori* closely resembles the exposed sandstone, suggesting a close evolutionary association between the skipper and exposed sandstone habitat. *L. c. pallida* is a widespread plant in southern Queensland (Henderson 1997), but in the sandstone habitats of central Queensland it appears to be the only *Lomandra* species that has adapted to growth in the narrow ecotone along the exposed sandstone cliffs. This restricted occurrence appears to be fire related and although the plant can survive occasional intense fires it appears to be intolerant of more frequent fires, being replaced by other *Lomandra* species in areas subject to more regular burning away from the rocky areas. The remarkable similarity between the seeds of *L. c. pallida* and the later larval head capsules of *T. taori*, together with the unusual habit of many larvae in constructing shelters opening at the level of the seeds and blocking the entrance of the shelter with their heads, further supports a long evolutionary association between *T. taori* and *L. c. pallida*.

Our findings to date indicate that the primary habitat of *T. taori* is a narrow ecotone less than 100 m wide along the cliffs and escarpments of the aptly named Precipice Sandstone Formation in central Queensland (Fig. 5). This Jurassic sandstone is exposed in a significant linear expression from Carnarvon Range through Lonesome National Park and Robinson National Park and connects to the north and east with Isla Gorge National Park. Although the main geological formation at Blackdown Tableland is Clematis Sandstone (which links Dawson, Shotover and Expedition Ranges), the cliff lines and gorges are Precipice Sandstone (Warner 1987). Other sandstone formations overlay the Precipice Sandstone, but this formation typically caps the mesas in Carnarvon Gorge and forms the walls of Carnarvon Range (Beetson and Gray 1993).

Throughout the sandstone environments there are numerous narrow but tall outcrops providing a maze of cliff lines that provide habitat for *L. c. pallida*. The dense dendritic drainage patterns further enlarge the linear component of this habitat.

Although the Precipice Sandstone Formation occurs as a thin zigzag line approximately 500 km from west to east, the major cliff outcrops are in the areas previously noted. In an attempt to estimate the length of suitable habitat (*ie.* outcropping sandstone cliff faces), we utilised the 1:250,000 topographic map sheets that cover the region and attempted to track the cliff lines by opisometer. Although clearly subject to errors of measurement and mapping, this revealed at least 1,000 km of cliffs. Blackdown Tableland was estimated to have 100 km of cliffs; Carnarvon Ranges west of the Injune to Rolleston Highway about 300 km; east of this highway down through Lonesome National Park and then east to Precipice Creek (type locality for the formation) includes another 300 km of cliffs; finally the Robinson Gorge National Park and north to Claire Range and Expedition Range includes a further 300 km.

The close association between the skipper, food plant and exposed sandstone habitat suggests that female *T. taori* may be unlikely to disperse far from exposed sandstone cliffs and raises the possibility of limited genetic interchange between populations in the more disjunct sandstone areas. There are a few small outliers disjunct from the main areas, including Isla Gorge which is 50 km away from its nearest neighbour outcrop. The Blackdown Tableland outcrop of Precipice Sandstone is approximately 100 km from its nearest neighbour, but the intervening areas along the Expedition Range include cliffs of other sandstone formations that may be suitable habitat for *T. taori*.

The largely uninterrupted continuum of suitable habitat, together with the lack of morphological differences in adults from disjunct localities, suggests that genetic isolation has not occurred. It is clear that the extensive lengths of the escarpment on private land play an important role in maintaining connectivity and habitat for this species.

Atkins (1997) listed an unconfirmed sighting of *T. taori* from near Springsure. However, the Minerva Hills area is not sandstone and a search of the Queensland Herbarium database showed no records of *L. c. pallida* from there, suggesting that this sighting should be regarded as doubtful.

Acknowledgements
We thank the Queensland Department of Environment for permits covering areas of National Park included in our study, local Parks and Wildlife staff for their keen interest and support during field studies and the Queensland Herbarium for identification of *Lomandra* species.

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ADDITIONAL NOTE ON A NEW SPECIES OF *NEODIPHTHERA* FLETCHER (LEPIDOPTERA: SATURNIIDAE) FROM NORTHEASTERN QUEENSLAND

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Abstract

The record of a female *Neodiphthera* Fletcher specimen from Groote Eylandt, Northern Territory, is confirmed.

Discussion

Lane and Naumann (2003) questioned the locality data for a specimen of *Neodiphthera* Fletcher from Groote Eylandt, Northern Territory. John d'Apice (pers. comm., 25 July 2003) has confirmed that the labelling of a pinkish brown female (Groote Eylandt, Northern Territory, 18.v.1982, J.W.C. d'Apice & V.J. Robinson) is correct.

This distribution record is a most unexpected one, as the genus is apparently absent from the Bamaga area at the tip of Cape York Peninsula, but present at Iron Range and Silver Plains in central Cape York Peninsula, in New Guinea, Aru Island of Indonesia, and on Groote Eylandt. Further collecting is required to confirm the status of specimens from this area, provisionally referred to *N. sulphurea* Lane & Naumann (Lane and Naumann 2003).

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SOME RECORDS OF BUTTERFLIES (LEPIDOPTERA) FROM WESTERN CAPE YORK PENINSULA, QUEENSLAND

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Abstract

Twenty-nine species of butterflies are reported from Kowanyama, southwestern Cape York Peninsula, of which 17 are newly recorded and eight confirmed from that area. In addition, nine species are newly recorded from Weipa, northwestern Cape York Peninsula.

Introduction

Distribution maps for Australian butterflies produced by Braby (2000) have highlighted the paucity of records from western Cape York Peninsula, northern Queensland. For Weipa, most previous records emanate from McCubbin (1972). For southwestern parts of the Peninsula (Kowanyama area) Dunn and Dunn (1991) mapped only four species, while distribution maps in Braby (2000) for other species are based on extrapolation rather than definitive records.

Collecting was undertaken by the present authors during an Australian Biological Resources Study of Cape York Peninsula from 1974-1977 (Monteith and Hancock 1977). Weipa was visited by GBM from 5-8 February 1975 and 3-7 February 1976. Kowanyama (28 km inland from the Gulf coast on Magnificent Creek, a tributary of the Mitchell River) was visited by DLH from 7-14 January 1977. A few additional specimens were collected at Weipa by K. DeWitte in February 1976.

Fifty-two species were recorded from Weipa and 29 from Kowanyama (Table 1). For Weipa, these wet season records supplement those made during the dry season by McCubbin (1972). Nomenclature follows Braby (2000) and voucher specimens are held in the Queensland Museum, Brisbane.

Records from Weipa

Collecting took place around Weipa township, Kerr (Hibberd) Point (an area with relict rainforest) and Andoom. This area lies in the Northeastern Floristic Zone (see Dunn and Dunn 1991).

The following species are newly recorded from Weipa: *Taractrocera ina*, *Ocybadistes ardea ardea*, *Suniana sunias rectivitta*, *Telicota colon argeus*, *Telicota mesoptis mesoptis*, *Graphium agamemnon ligatum*, *Papilio fuscus capaneus*, *Arhopala wildei*, *Zizula hylax attenuata*.

Delias mysis mysis and *Hypolimnas misippus* were collected at Weipa by K. DeWitte in February 1976, along with *Papilio aegeus aegeus, Cressida cressida cressida, Catopsilia pomona, Mycalesis perseus perseus*, *Precis orithya albicincta* and *Precis hedonia zelima*.

Table 1. Butterflies recorded at Kowanyama in January 1977 and at Weipa in February 1975 and February 1976. A = Kowanyama township; B = Magnificent Creek, upstream of township; C = stock camp, 15 km from township; D = Weipa township [x = 1975; o = 1976]; E = Kerr Point [1976]; F = Andoom [1976].

	Kowanyama			Weipa		
	A	B	C	D	E	F
HESPERIIDAE						
Tagiades japetus janetta Butler				x	x	x
Taractrocera ina Waterhouse	x				x	x
Ocybadistes walkeri sothis Waterhouse						x
Ocybadistes ardea ardea Bethune-Baker	x				x	
Suniana sunias rectivitta (Mabille)				x	x	
Telicota colon argeus (Plötz)				x	x	x
Telicota augias krefftii (W.J. Macleay)				x	x	
Telicota mesoptis mesoptis Lower	x				x	
Pelopidas lyelli lyelli (Rothschild)	x	x	x			
PAPILIONIDAE						
Graphium sarpedon choredon (C. & R. Felder)					x	
Graphium macfarlanei macfarlanei (Butler)					x	
Graphium agamemnon ligatum (Rothschild)					x	
Papilio aegeus aegeus Donovan				o	x	
Papilio fuscus capaneus Westwood	x			x	x	
Papilio ulysses joesa Butler [sight record]				o		
Papilio demoleus sthenelus W.S. Macleay	x	x				
Cressida cressida cressida (Fabricius)	x			x	x	x
Pachliopta polydorus queenslandicus (Rothschild)						x
PIERIDAE						
Catopsilia pomona (Fabricius)	x	x		o	x	
Eurema laeta sana (Butler)	x	x			x	
Eurema hecabe hecabe (Linnaeus)		x		x	x	x
Elodina walkeri Butler					x	
Cepora perimale scyllara (W.S. Macleay)					x	
Appias paulina ega (Boisduval)					x	
Delias mysis mysis (Fabricius)				o		
NYMPHALIDAE						
Melanitis leda bankia (Fabricius)	x			x	x	x
Mycalesis perseus perseus (Fabricius)	x	x	x	x	x	x
Mycalesis terminus terminus (Fabricius)				x	x	
Ypthima arctoa arctoa (Fabricius)				x	x	
Pantoporia consimilis consimilis (Boisduval)	x	x				

	Kowanyama			Weipa		
	A	B	C	D	E	F
NYMPHALIDAE (cont.)						
Pantoporia venilia moorei (W.J. Macleay)					x	
Phaedyma shepherdi shepherdi (Moore)					x	x
Hypolimnas alimena lamina Fruhstorfer				x	x	x
Hypolimnas bolina nerina (Fabricius)	x	x	x	x	x	
Hypolimnas misippus (Linnaeus)				o		
Precis orithya albicincta Butler	x			x	x	x
Precis villida calybe (Godart)	x			x	x	
Precis hedonia zelima (Fabricius)	x	x	x	o	x	
Danaus chrysippus petilia (Stoll)	x	x	x		x	x
Danaus affinis affinis (Fabricius)	x		x	x	x	x
Euploea sylvester sylvester (Fabricius)	x					
Euploea darchia niveata (Butler)					x	
Euploea core corinna (W.S. Macleay)	x	x	x		x	
Euploea alcathoe eichhorni Staudinger	x					
Tellervo zoilus gelo Waterhouse & Lyell					x	
LYCAENIDAE						
Hypochrysops polycletus rovena Druce						x
Arhopala centaurus centaurus (Fabricius)	x		x			
Arhopala micale amytis (Hewitson)				x	x	
Arhopala wildei Miskin					x	
Hypolycaena phorbas phorbas (Fabricius)		x	x		x	x
Anthene seltuttus affinis (Waterhouse & Turner)	x		x			
Anthene lycaenoides godeffroyi (Semper)		x				
Candalides erinus erinus (Fabricius)				x	x	
Nacaduba berenice berenice (Herrich-Schäffer)					x	
Psychonotis caelius taygetus (C. & R. Felder)					x	x
Catochrysops panormus platissa (Herrich-Schäffer)	x	x		x		
Zizeeria karsandra (Moore)	x	x			x	
Zizina labradus labdalon Waterhouse & Lyell	x					
Famegana alsulus alsulus (Herrich-Schäffer)					x	x
Zizula hylax attenuata (T.P. Lucas)				x		
Euchrysops cnejus cnidus Waterhouse & Lyell					x	

Records from Kowanyama

Collecting took place around Kowanyama township, along Magnificent Creek (0-6.5 km upstream of township) and at a stock camp about 15 km from the township. This area lies in the Northern Floristic Zone (see Dunn and Dunn 1991).

Seventeen of the 29 species known from Kowanyama are newly recorded: *Taractrocera ina*, *Ocybadistes ardea ardea*, *Telicota mesoptis mesoptis*, *Pelopidas lyelli lyelli*, *Papilio fuscus capaneus*, *Eurema laeta sana*, *Melanitis leda bankia*, *Mycalesis perseus perseus*, *Precis orithya albicincta*, *Precis hedonia zelima*, *Danaus affinis affinis*, *Euploea alcathoe eichhorni*, *Arhopala centaurus centaurus*, *Hypolycaena phorbas phorbas*, *Anthene lycaenoides godeffroyi*, *Catochrysops panormus platissa*, *Zizina labradus labdalon*.

Occurrence of eight other species at Kowanyama is confirmed: *Papilio demoleus sthenelus*, *Catopsilia pomona*, *Eurema hecabe hecabe*, *Danaus chrysippus petilia*, *Euploea sylvester sylvester*, *Euploea core corinna*, *Hypolimnas bolina nerina*, *Precis villida calybe*. An additional species, *Anthene seltuttus affinis*, was recorded by Dunn and Dunn (1991) and Braby (2000) but inadvertently omitted from the map in Braby (2000).

Specimens of *Arhopala centaurus centaurus* from Kowanyama are a duller purple than usual and, like the Karumba specimen recorded by Dunn and Dunn (1991) and Braby (2000), are difficult to place to subspecies, showing some resemblance to *A. c. asopus* Waterhouse & Lyell. All specimens of *Eurema laeta sana* collected belong to the wet-season form. Males of *Papilio demoleus sthenelus*, *Eurema laeta sana*, *Hypolimnas bolina nerina*, *Catochrysops panormus platissa* and *Zizeeria karsandra* were collected at mud puddle aggregations.

Other records

The following records of interest are noted also, extending the known distributions south of Iron Range and reducing the gap between these northern populations and those further south. Localities are mapped in Monteith and Hancock (1977).

Suniana sunias rectivitta. Mt White near Coen, Peach Creek, McIlwraith Range and near Stewart River mouth (June-July 1976 - GBM & M. De Baar).

Arhopala wildei. Peach Creek near McIlwraith Range (June-July 1976 - GBM & M. De Baar); near Stewart River mouth (June-July 1975 - GBM).

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HOST PLANT AND SEASONAL ABUNDANCE OF *BACTROCERA VISENDA* (HARDY) (DIPTERA: TEPHRITIDAE)

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Abstract

Host plant records from northern Queensland suggest that *Bactrocera visenda* (Hardy) is monophagous on *Garcinia warrenii* (native mangosteen: Clusiaceae). Populations of *B. visenda* increased markedly from November to February annually, which correlates well with the fruiting period for *G. warrenii*. Almost all *G. warrenii* fruit collected produced *B. visenda*, which was not reliably reared from any other host. A record from *G. gibbsiae* remains unconfirmed. *B. visenda* was not reared from cultivated mangosteen (*G. mangostana)* and is unlikely to become an economic pest of cultivated fruit in this region.

Introduction

An increasing variety of native and tropical fruit is being grown in northern Queensland, but the pest status of many endemic rainforest fruit flies remains unknown. As part of the Papaya Fruit Fly Eradication Campaign (1995-99), an extensive trapping and fruit collection survey was conducted to establish breeding sites and host fruits of *Bactrocera papayae* Drew & Hancock and other fruit flies. *Bactrocera visenda* (Hardy) was found to be one of the most frequently trapped fruit flies yet, despite its abundance, comparatively little is known about its biology. Two hosts, *Garcinia warrenii* and *G. gibbsiae* (Clusiaceae) have been reported previously (May 1957, 1960, Drew 1989). An earlier record from *G. kajewskii* (Hardy 1951) almost certainly refers to *G. warrenii* (Hancock *et al*. 2000). There is no information on the importance of these hosts to *B. visenda*, nor on any changes in its seasonal abundance.

Methods

Trapping

During the eradication campaign, *B. papayae* populations were monitored using Steiner traps baited with methyl eugenol lures. Trap placement was on a 1 km grid where eradication treatments were intensive, and at 5-10 km intervals in more remote areas. Traps were cleared weekly and their contents identified. Most traps were checked only for the presence of *B. papayae*. However, selected traps in rainforest areas and study areas had all fruit flies counted and identified to species and these provided data on *B. visenda*.

Fruit Collecting

As an adjunct to lure trapping, a project was initiated during the eradication campaign to elucidate the host fruit range of *B. papayae* and other fruit flies. Fruit was collected from farms, orchards, suburban yards, rainforest and produce markets. Fruit samples were held in a laboratory under controlled temperature (27°C) and humidity (70%) until fruit flies emerged. After emergence, fruit flies were left for a further 7 days to mature and colour, then

killed in a freezer. Fruit flies were then identified, with numbers of each species, host fruit and collection location being recorded.

Results

From January 1996 to March 1998 a total of 101,538 *B. visenda* was obtained from 22,852 trap samples. The seasonal abundance pattern for *B. visenda* is given in Fig. 1 and shows a marked increase between December and February annually. This coincides with the known fruiting pattern of *G. warrenii* (Cooper and Cooper 1994).

Fruit of four species of *Garcinia* was collected, but *B. visenda* was recovered only from *G. warrenii* (Table 1). *G. mangostana,* the only commercially grown mangosteen, produced no *B. visenda* during this study.

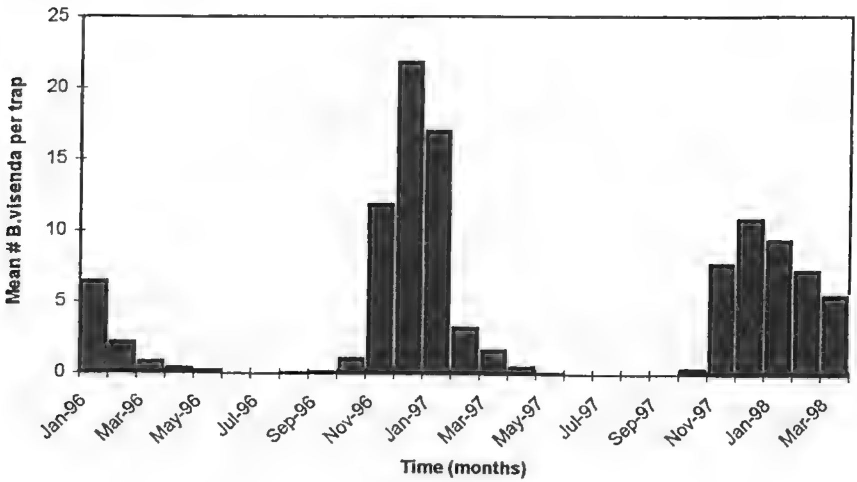

Fig. 1. Seasonal abundance of *Bactrocera visenda* from methyl eugenol traps in northern Queensland.

Discussion

The results indicate that *Bactrocera visenda* is monophagous on *Garcinia warrenii.* There is no evidence to suggest that *G. mangostana* or any other mangosteens surveyed are hosts of *B. visenda*. May (1960) recorded *G. gibbsiae* as a host, but the reliability of this report is unknown and it requires confirmation (D.L. Hancock, pers. comm.). *G. gibbsiae* was not collected during the survey and this record remains unconfirmed. May (1957) indicated that *G. gibbsiae* is a major host of *B. expandens* (Walker), which was reared from *G. dulcis* but not from *G. warrenii* during the survey.

Garcinia gibbsiae fruits from July to January, whereas *G. warrenii* fruits primarily from October to January (Cooper and Cooper 1994). *B. visenda* were reared between September and March and the seasonal increase in adult abundance (Fig. 1) correlates well with the fruiting period of *G. warrenii.* As very low numbers of adults were collected in lure traps between May and October, it is possible that *B. visenda* overwinters as largely non-lure responding (and non-breeding) adults in moist, shady forest areas.

Table 1. Fruit fly rearing data from *Garcinia* spp.

Garcinia species	No. of samples collected	No. of samples that produced fruit flies	No. of samples that produced *B. visenda*
G. mangostana	75	3	0
G. dulcis	60	8	0
G. xanthochymus	2	0	0
G. warrenii	68	66	66

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BOOK REVIEW

The action plan for Australian butterflies. By D. P. A. Sands and T. R. New. Environment Australia, Canberra; October 2002; v + 377 pp. ISBN 0642548498. Available from Environment Australia, GPO Box 787, Canberra, ACT 2601.

In the past, butterfly conservation in Australia, particularly Queensland, has been a largely legislative affair based on little or no scientific evidence. The inclusion of many common or vagrant species on protected lists has served to undermine credibility in the process, whereas severe restrictions placed on collecting have inhibited further study of species genuinely or potentially in need of conservation.

This volume effectively redresses these deficiencies, providing solid scientific evidence for inclusion of species in conservation categories based on IUCN criteria. Much of the base data for the species assessments was gathered from amateur enthusiasts during a series of workshops held throughout the country. These are the very people most affected, adversely and unnecessarily, by restrictive legislation based on species lists rather than habitat reserves.

Of the 654 butterfly species and subspecies recognised by the authors, synopses discuss the conservation concerns attributed previously to 219 taxa [220 stated in text but there is no number 174]. This covers the bulk of the report and includes costings for species where further research or conservation measures are considered necessary. Significantly, three common species long known to be of no conservation significance despite legislation since the 1970s, *Ornithoptera euphorion*, *O. priamus* and *Papilio ulysses*, are recommended for deletion from protective lists. Allowing new enthusiasts to collect and study these showy species in the wild may well help foster an appreciation of the natural environment (as it did with the present reviewer before legislation), leading to a future generation of conservationists.

The total budget suggested for research, surveys and restoration work needed for species of concern does not include land acquisition costs but, at $2,369,300, is well below that recommended for similar work on vertebrates such as birds (Endersby 2003). It seems a small price to pay for conservation within a group of insects often regarded as of flagship importance in environmental quality assessments.

Two appendices provide National, State and Municipal recommendations for 26 taxa considered threatened (critically endangered, endangered and vulnerable) and a further 79 taxa considered of lower risk or data deficient. A third appendix tabulates distribution and previous threat assessments for all 654 taxa. This work is a valuable and highly recommended addition to the library of everyone interested in butterflies and/ or conservation.

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D. L. Hancock
Cairns

THE LIFE HISTORY AND DISTRIBUTION OF *RACHELIA EXTRUSA* (C. & R. FELDER) (LEPIDOPTERA: HESPERIIDAE: TRAPEZITINAE) IN AUSTRALIA

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Abstract

The life history of *Rachelia extrusa* (C. & R. Felder) is described and a significant southern range extension to the Rocky River area of Cape York Peninsula recorded. The larval food plant is *Flagellaria indica* L. (Flagellariaceae), occurring as distinct forms under closed canopy rainforests. High levels of egg and larval parasitism are recorded from the Rocky River population. The juvenile stages confirm the morphological links of *Rachelia* Hemming with both the Trapezitinae and Hesperiinae.

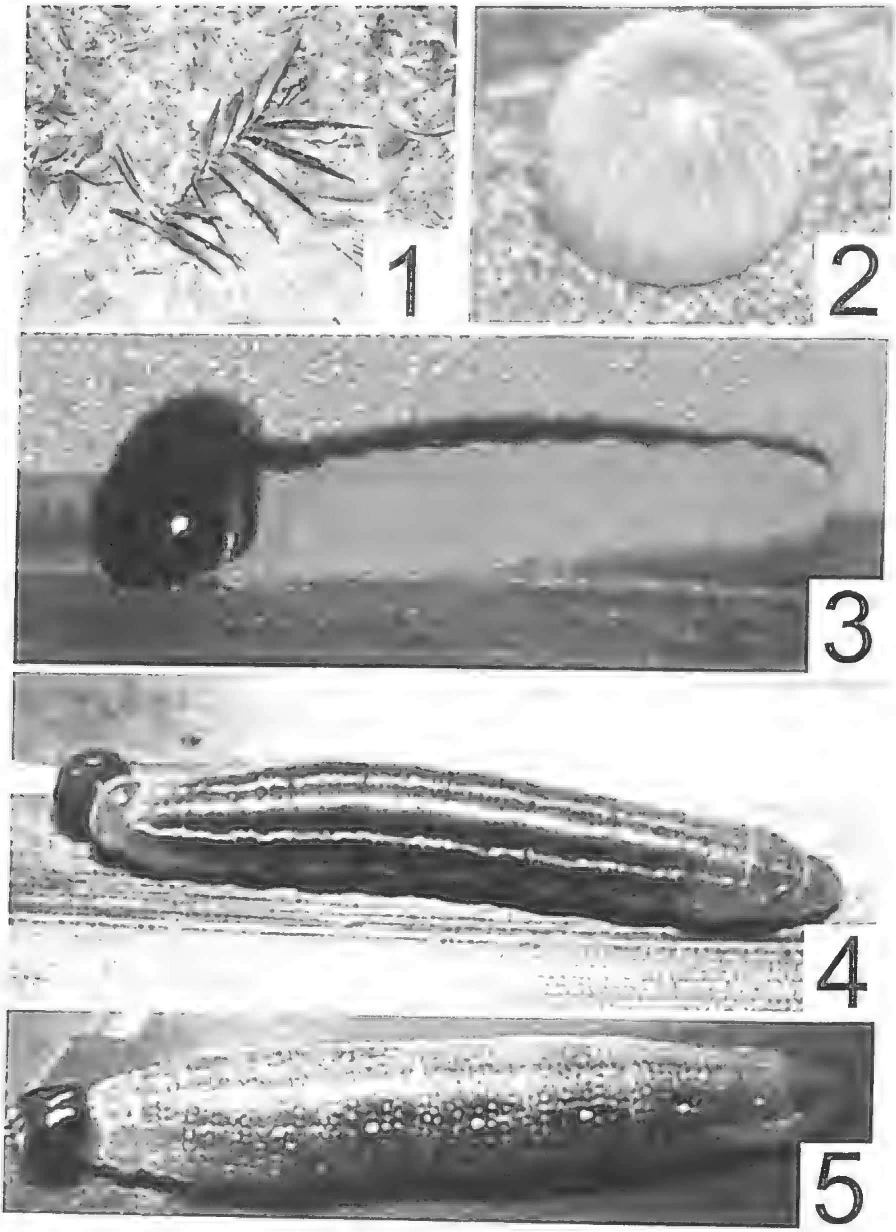
Introduction

Rachelia extrusa (C. & R. Felder) was first recorded in Australia from specimens collected at Iron Range, Queensland in May and June 1973 (Atkins 1975). Although six adults have also been collected in Papua New Guinea (Parsons 1999), nothing was known about the juvenile stages or food plants and some speculation has occurred about its taxonomic links (Atkins 1975, Parsons 1999).

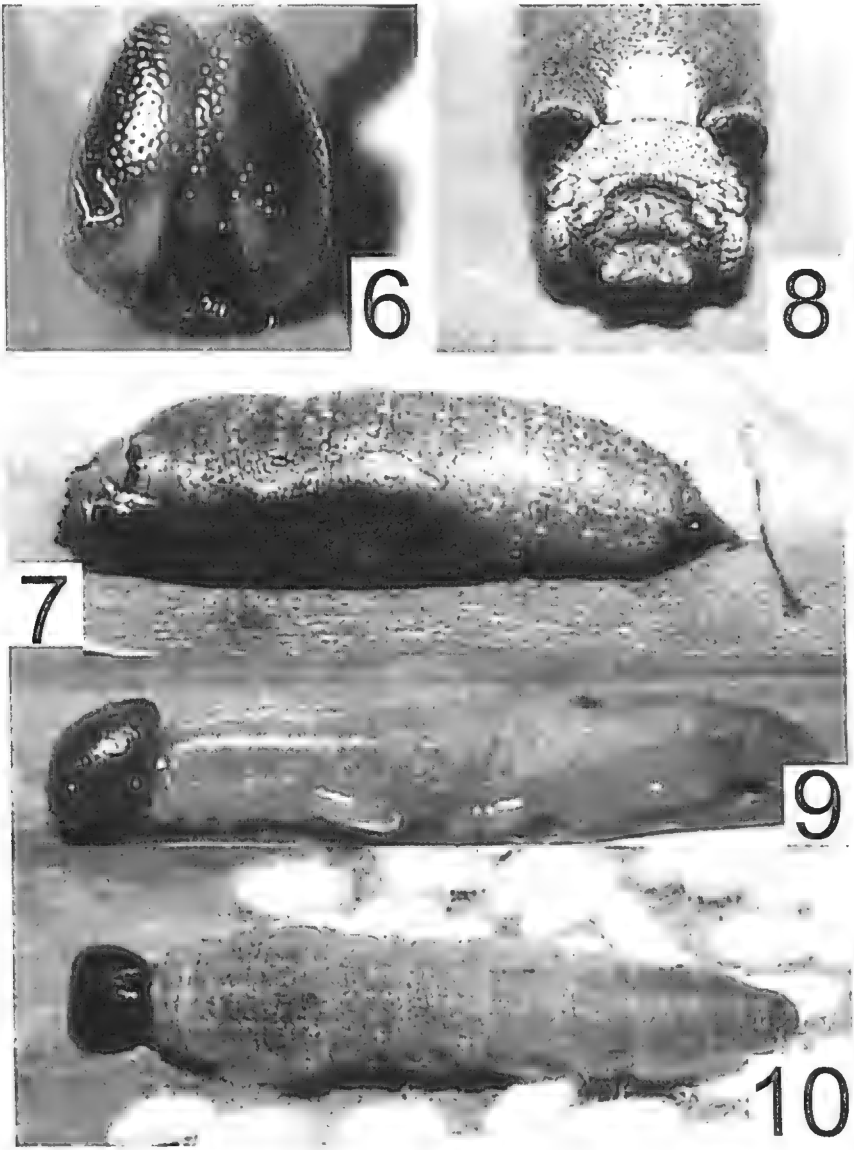
Within Australia the species is known from a restricted distribution (Atkins 1975, Braby 2000). All specimens in collections have been taken at a limited number of sites within the Iron Range area, mainly males aggregating at a canopy lek in the vicinity of Gordon Creek. Occasional individuals have also been taken near Mt Tozer and along roadsides within a few square kilometres of the Iron Range Resources Reserve.

Field surveys

In late April 2002, during a field survey at Rocky River (13°49'57"S, 143°27'05"E), an area on the south-eastern edge of the McIlwraith Range about 40 km north of the Silver Plains Station on Cape York Peninsula, Queensland, we discovered an unknown early instar larva. The larva had made a tubular shelter in a leaf of a *Flagellaria indica* L. plant under the rainforest canopy, in habitat situations typical for *Telicota brachydesma* Lower larvae that were present in the same location (Valentine and Johnson, 2000). The larva was taken to Townsville for rearing and by late May its appearance indicated that it was new to present knowledge. The presumed final instar shape appeared somewhat trapezitine although, superficially, it also resembled larvae of Pyrginae and Hesperiinae. We suspected that it was the unknown larva of *R. extrusa* but remained uncertain, in part because this species was not known at Rocky River. On 25 May, 40 hymenopteran parasitoids emerged from the larva and pupated.



Figs 1-5. (1) larval food plant of *R. extrusa*, the distinct low narrow-leaf form of *Flagellaria indica* L. (2-5) juvenile stages of *R. extrusa*: (2) egg; (3) first instar larva; (4) fourth instar larva; (5) final instar larva.



Figs 6-10. Juvenile stages of *R. extrusa*. (6) larval head cap; (7) lateral view of pupa; (8) pupal cap; (9) parasitic emergence from third instar larva; (10) parasitic emergence from final instar larva.

In July 2002 we returned to the Rocky River site to search for more of these larvae. At this stage it was not clear that the species was confined to very specific habitat and to particular forms of *F. indica* and, while a number of hesperiid larval shelters were located, only one specimen of the new larva was found. By late August this second specimen had also succumbed to hymenopteran parasitoids.

In November 2002 we conducted a third search at Rocky River and located additional hesperiid larvae on *F. indica* plants. These were returned to Townsville for rearing. Yet again our efforts were frustrated when some of the larvae proved to be *Telicota augias krefftii* (W.J. Macleay) and remaining larvae were parasitised by different parasitic wasps. However, by now we had correctly identified the preferred forms of *F. indica* for the new larva and we once again returned to Rocky River in early May 2003. On this occasion we were able to locate fresh and parasitised eggs as well as many larvae ranging from first instar to third instar. Despite continuing examples of parasitism we were finally able to rear several larvae through to adults, including one from an egg. During this period we communicated our preliminary findings to Peter Wilson, who undertook searches at Iron Range and located larvae, which were reared to adults (P. Wilson, pers. comm.).

Life History

Food plant (Fig. 1). *Flagellaria indica* L. (Flagellariaceae).

Egg (Fig. 2). Pale pink, hemispherical, 0.9 mm high, 1.2 mm wide at base, 21-25 vertical ribs (n=6).

First instar larva (Fig. 3). Head shining black, slightly narrower at top with slight median sulcus, a few scattered fine setae; body pale yellow with a prominent wedge-shaped black prothoracic plate; abdominal segments with pair of dorsal and ventrolateral setae anteriorly and dorsolateral setae posteriorly; small lateral setae above prolegs; A8 and anal plate with pair of long curved setae posteriorly; spiracles brown. Length 3 mm.

Second and third instar larvae. Head brownish red, pear-shaped with mid-dorsal cleft; pale brown along sulcus and frontoclypeal sutures; frontoclypeus dark brown. Body pale green with dorsal heart edged white from T3 to A9 and dorsolateral white lines from T2 to A9, both lines becoming fragmented into spots on posterior segments; anal plate pink with pink suffusion extending anteriorly onto A8 and 9. Length 6-15 mm.

Fourth instar larva (Fig. 4). Similar to third instar but body pinkish brown.

Final instar larva (Figs 5-6). Head reddish brown; pear-shaped with deep sulcus dorsally producing 2 short horns; pale whitish central stripe from tip of horns along frontoclypeal suture to ventrolateral margin; small central white patch dorsally on frontoclypeus. Body pinkish brown; prothorax pale cream anteriorly and translucent posteriorly; mesothorax deeper pink dorsally;

dorsal heart darker green; faint whitish dorsal and lateral lines. Abdominal segments with transverse lines of small pale white spots and a single prominent white spot on lateral line on each segment; covered in short pale setae with expanded tips; ventrolateral margin of segments 7 and 8 appear scalloped when at rest; anal plate rugose, dark reddish brown, semicircular, narrower than preceding segments and bearing 2 pairs of long pale setae on lateral margin; spiracles whitish. Length 16-25 mm.

Pupa (Figs 7-8). Length 22-24 mm. Cylindrical, tapering gradually to an elongated, slightly decurved dorso-ventrally flattened cremaster with prominent black lateral pits and attached to a stout transverse silken thread. Greyish brown, paler posteriorly; abdominal segments 1-8 with dorsolateral white spots, a pair of white lateral spots on meso and metathorax; spiracles white edged orange brown, body covered in erect straight or slightly curved simple setae some with flattened tips. Prominent semicircular black spiracular plates; dorsal mesonotum, prothorax, antennal bases and ventral mandibular areas white with irregular brown fissures; frons pale brown with prominent dorsal and ventral rugose protrusions, dark patches dorsally, ventrolaterally and on ventral side of dorsal protruberances; attached by strong central girdle across thorax.

Discussion

There are three main forms of *F. indica* at both Iron Range and Rocky River. One is a very thick-stemmed plant that climbs strongly to the canopy and has large coarse leaves. Another form has very fine small leaves and a slightly zig-zag appearance as it climbs a few metres high under the canopy. It has a spindly habit. The third form has small to medium leaves and typically occurs as a low upright or sometimes sprawling plant, usually <1 metre high but sometimes taller. The stems are slightly broader than the zig-zag form but much finer than the giant form. It is possible that this third form is merely a seedling of the giant form, perhaps subject to the common rainforest phenomenon of seedling still-stand. All larvae found to date have been on the smaller forms with a preference at Rocky River for the third form. All three forms may occur in close proximity but the two smaller forms are most common under the rainforest canopy. Queensland Herbarium staff believe all three forms are of the one species (pers. comm., Henderson 1997). In captivity larvae readily accepted all forms.

Eggs are laid on the underside edge of a leaf of the food plant and upon hatching the first instar larva consumes part or all of the eggshell. It then constructs a shelter at the tip of the leaf by silking together a tube, usually joined dorsally. Initial feeding occurs along the edge of this leaf between the shelter and the leaf base. Subsequent shelters may involve one or more leaves joined to form a tube or occasionally the leaf may be doubled back and silked at the edges to form a 'sock'.

In situations where suitable shelters are unable to be formed within leaves of the plant, later instar larvae leave the plant and make shelters in leaf litter near the base of the plant. In captivity provision of dried leaves at the base of small potted plants led to final instar occupation and silking of these dried leaves into shelters much like that of a typical off-plant shelter of *Trapezites* Hübner species. Larvae pupated in these dried leaf shelters and fashioned silk thoracic girdles and attached the cremaster to a strong lateral posterior line. Pupal duration of captive reared larvae was 17-21 days in Townsville in June/July and 17 and 19 days in Bundaberg in September and May respectively. During May to July in Townsville it took 54 days from egg to pupa.

Fig. 11. Underside of freshly emerged adult male *R. extrusa* from Rocky River, showing dense hairs.

The form of the egg and pupa is consistent with that seen in Trapezitinae, especially *Trapezites* spp., but the larval form and presence of a strong central girdle in the pupa are closer to *Notocrypta* de Niceville spp. (Hesperiinae). It is interesting to note the comment in Parsons (1999) that a sketch by Brandt of the unknown food plant of *Notocrypta aluensis* Swinhoe appears to show *F. indica.*

The preferred habitat of larval *R. extrusa* is on small *F. indica* plants (Fig. 1) growing under closed canopy rainforest. All eggs and larvae found to date at both locations have been within 500-700 mm of the ground and small plants are often denuded of leaves by developing larvae.

The level of parasitism in the Rocky River population of *R. extrusa* seems remarkably high. We observed parasitism in eggs, early instar larvae and final instar larvae (Figs 9-10). One possible explanation may be the more open nature of the habitat for *R. extrusa.* Many of the locations where larvae were found at Rocky River had very limited undergrowth and the *F. indica* plants were prominent against a relatively bare ground (in several cases even more so where leaf litter was swept into the nest mounds of Yellow-footed Scrub-hens). Identification of the parasitoids to species has not been possible and voucher specimens have been lodged in the Queensland Museum. There are two families represented, Eulophidae and Braconidae (M. Elson-Harris, pers. comm.).

The absence of adults paralleled our experience with *T. brachydesma* in that even when large numbers of larvae were found, no adults were encountered. In many visits to Rocky River only one adult *T. brachydesma* has so far been encountered, despite many hundreds of larvae being seen. It is likely that in both species the low light conditions under the canopy and the cryptic colouration of the adults precludes easy observation of females laying eggs. Males in both cases are likely to be in the upper canopy. In the case of *R. extrusa* this is certainly true at Iron Range. Further surveys at Rocky River are required to discover male leks. Freshly emerged adults are particularly hairy in the ventral thoracic region and on their legs (Fig. 11).

Sands and New (2002) considered *R. extrusa* to be of 'no conservation concern' despite its extremely limited distribution and unknown life history. Our significant range extension and life history discovery enhance the basis by which its conservation status may be assessed. *F. indica* occurs commonly in rainforests throughout Torres Strait and Cape York Peninsula and *R. extrusa* may well have a wider distribution within Australia than is currently known. There is no evidence of any direct anthropogenic threats to the species; however, occasional minor food plant damage from feral cattle and pigs is evident at Rocky River. Given the above and the current plans for the McIlwraith Range to be gazetted as a protected area (QPWS, pers. comm.) we agree with the Sands and New (2002) assessment.

Acknowledgements

The Queensland Parks and Wildlife Service is acknowledged for scientific permits under which this work was conducted. Our colleague Mr Peter Wilson is thanked for information about his searches at Iron Range, as are Mr Sunlight Bassini and the Lama Lama people for access through the Silver Plains station. The authors acknowledge the Umpila people as traditional owners of the Rocky River sites. We also thank Marlene Elson-Harris of Queensland Department of Primary Industries for identification of parasitoids.

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NOTES ON THE STATUS OF SOME *ELODINA* C. & R. FELDER SPECIES (LEPIDOPTERA: PIERIDAE)

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Abstract

The status of *Elodina tongura* Tindale, *E. queenslandica* De Baar & Hancock, *E. q. kuranda* De Baar & Hancock, *E. walkeri* Butler, *E. umbratica* Grose-Smith, *E. sada* Fruhstorfer, *E. hypatia hypatia* C. & R. Felder and *E. egnatia* (Godart) is discussed. Twenty-six species and ten subspecies of *Elodina* C. & R. Felder are recognised.

Introduction

The genus *Elodina* C. & R. Felder, 1865, contains a variable number of recognised species (16 according to Parsons 1998, 23 according to Yata 1985), of *Capparis* (Capparaceae) feeding butterflies. Continuing uncertainty as to the status of certain Australian and New Guinea taxa has prompted a critical review of Braby (2000), De Baar and Hancock (1993a), Parsons (1998) and Yata (1985), together with a reinterpretation of the status of a few other taxa. The 26 species and 10 subspecies recognised as a result of this review, together with their general distributions, are listed in Table 1.

Discussion

Elodina tongura

E. tongura Tindale was regarded as a valid species by De Baar and Hancock (1993a). Braby (2000) considered it to be 'a wet season form of *E. walkeri*' and ignored the much longer vesica of the male genitalia compared with that of *E. walkeri* Butler. Hancock (2001) noted (in a review of Braby 2000) that '*Elodina tongura* has been placed as a seasonal form of *E. walkeri*, despite differences in the aedeagus and its restriction to coastal and insular Northern Territory; [but] a seasonal form would be expected to occur throughout the range of the species, including Queensland.' Hancock (2001) also noted that 'many pierid genera contain cryptic species that are difficult to tell apart.'

Parsons (1998: p. 289) stated 'It also appears that the taxon *tongura* Tindale ... might belong to *definita*.' *E. definita* Joicey & Talbot is known from across New Guinea but, unlike *E. tongura*, it has a well defined subapical band on the underside of the forewing.

Recently, a small series of *Elodina* was collected north of Woolner Station, 60 km east of Darwin, Northern Territory, flying among thorny branches of a *Capparis* tree near the sea, behind coastal marshlands (D.P.A. Sands, pers. comm.). Specimens from this series were examined by both the present author and D.L. Hancock (pers. comm.), who considered it to contain both *E. tongura* and *E. walkeri* (Sands and New 2002). This collection thus demonstrates a distributional overlap between *E. walkeri* and *E. tongura*.

Table 1. *Elodina* species and subspecies and their general distributions.

Elodina taxa	Distribution
E. leefmansi Kalis, 1934	eastern Java
E. pura Grose-Smith, 1895	Pura, Alor, Adonara, Pantar & Flores (Lesser Sunda Is)
E. sota Eliot, 1956	southern Sulawesi
E. dispar Rober, 1887	Banggai Archipelago (E of Sulawesi)
E. egnatia egnatia (Godart, 1819)	Ambon, Seram (southern Moluccas)
E. e. bouruensis Wallace, 1867	Buru (southern Moluccas)
E. e. cirrha (Boisduval, 1832)	Halmahera (northern Moluccas)
E. e. boisduvali Fruhstorfer, 1911	northern Sulawesi
E. e. fruhstorferi Rober, 1919	Timor, Sumba (Lesser Sunda Is)
E. e. tenimberensis Joicey & Talbot, 1922	Tanimbar (eastern Lesser Sunda Is)
E. invisibilis Fruhstorfer, 1910	Wetar (Lesser Sunda Is)
E. therasia C. & R. Felder, 1865	Halmahera (northern Moluccas)
E. anticyra Fruhstorfer, 1910	Numfoor & Roon Is, (Geelvink Bay, West Papua)
E. hypatia hypatia C. & R. Felder, 1865	New Guinea & surrounding islands
E. h. litana Fruhstorfer, 1910	Kei Is
E. biaka Joicey & Noakes, 1915	Biak I., northern West Papua
E. aruensis Joicey & Talbot, 1922	Aru Is
E. definita Joicey & Talbot, 1916	New Guinea
E. andropis andropis Butler, 1876	Central Province, Papua New Guinea
E. a. namatia Fruhstorfer, 1910	Waigeo I. & northern West Papua
E. a. hydatis Fruhstorfer, 1910 [= *Elodinesthes effeminata* Fruhstorfer]	Morobe Province & D'Entrecasteaux group, Papua New Guinea
E. umbratica Grose-Smith, 1889	Choiseul to San Cristobal & Santa Ana, Solomon Islands
E. sada Fruhstorfer, 1910	Waigeo I. & New Guinea
E. primularis Butler, 1882	New Britain, Duke of York I. & New Ireland (Bismarck Archipelago)
E. argypheus Grose-Smith & Kirby, 1890	Bougainville, Choiseul, Santa Isabel, Guadalcanal (Solomon Archipelago)
E. signata signata Wallace, 1867	New Caledonia
E. s. pseudanops Butler, 1877	Lifu (Loyalty Is)
E. parthia (Hewitson, 1853)	Cape York Peninsula, Queensland, to central eastern New South Wales
E. padusa (Hewitson, 1853)	Australia (except SW Western Australia & Tasmania)
E. walkeri Butler, 1898	far northern areas of Australia
E. tongura Tindale, 1923	coastal Northern Territory, Australia

Elodina taxa	Distribution
E. perdita Miskin, 1889	central eastern Queensland
E. claudia De Baar & Hancock, 1993	mid Cape York Peninsula, northern Queensland
E. angulipennis (P.H. Lucas, 1852)	central eastern Queensland to central eastern New South Wales
E. queenslandica queenslandica De Baar & Hancock, 1993	Cape York Peninsula, northern Queensland
E. q. kuranda De Baar & Hancock, 1993	NE to SE Queensland

On present evidence, based on male genitalia, the more distinct yellow basal flash of the forewing underside in *E. tongura* (subdued in *E. walkeri*), its usually larger size, its confinement to the northern coastal regions and islands of the Northern Territory (*E. walkeri* occurs across northern Australia), the absence of a dark patch on the underside of the forewing apical area (not so for *E. definita* Joicey & Talbot, which has a rather distinct patch or band), it is concluded that *E. tongura* should be retained as a distinct species.

Elodina queenslandica

E. queenslandica and its subspecies *E. q. kuranda* were described recently by De Baar and Hancock (1993a). Parsons (1998: p. 285) stated 'However, *queenslandica* is apparently merely a subspecies of the earlier described NG taxon *andropis*' and, in the *E. andropis* Butler section (p. 287), further stated 'It also appears that the taxon *queenslandica*, and particularly its subspecies *kuranda* ... might belong to *andropis*.' *E. andropis* is a distinctive species represented by three subspecies (*E. a. andropis, E. a. namatia* Fruhstorfer and *E. a. hydatis* Fruhstorfer), which always has a broad subapical/ subterminal band on the forewing underside, although in *E. a. namatia* this band is not as broad as in the other subspecies.

E. q. queenslandica and *E. q. kuranda* both have a uniformly white hindwing underside on black and white prints when photographed under ultraviolet light; however, *E. a. andropis* and *E. a. hydatis* have an intensely black thin marginal line (data from ultraviolet-reflection photographic studies undertaken for the review by De Baar and Hancock 1993a; *E. a. namatia* not studied). The hindwing upperside margins are broadly banded brown-black in both sexes of *E. a. andropis* and in males of *E. a. namatia* and sometimes there are brownish submarginal patches present in females of *E. a. hydatis*; these features are not present in *E. queenslandica*. The forewing underside subapical/ subterminal darker band is always broader in *E. a. andropis* and *E. a. hydatis* than in *E. queenslandica*. This is very noticeable in *E. q. queenslandica*, which occurs geographically closest to *E. andropis*. The forewing underside basal flash is yellow-orange in *E. q. queenslandica* but subdued in *E. q. kuranda, E. a. andropis* and *E. a. hydatis*.

Braby (2000) did not recognise subspecies in *E. queenslandica*, based on variations in the forewing underside subapical/ subterminal band. However, *E. q. queenslandica* consistently lacks projections on the upper forewing apical black area between veins CuA_1 and CuA_2. As noted above, the forewing underside basal flash is yellow-orange in *E. q. queenslandica*, even in many specimens examined from Iron Range, Cape York Peninsula, but this is subdued in *E. q. kuranda*, a feature Braby (2000) did not discuss. The taxonomic and distributional boundaries between these two taxa might need further investigation. Braby (2000) also stated that specimens from the Yeppoon-Rockhampton area 'have very distinct genitalia' but no details were provided. Both Braby (2000) and De Baar and Hancock (1993b) indicated a need for further life-history studies. Moss *et al.* (1996) stated 'it appears likely that habitat requirements between the two species [*E. angulipennis* (P.H. Lucas) and *E. queenslandica*] may differ, with *E. q. kuranda* preferring moister habitats.' It is concluded that further work is necessary before these subspecific taxa are casually sunk.

Elodina walkeri, *E. sada* and *E. umbratica*

E. walkeri Butler was regarded as a distinct species by De Baar and Hancock (1993a). Parsons (1998) amalgamated *E. umbratica* Grose-Smith [type locality Ulawa I. (Ulaua)] and *E.* [*hypatia*] *sada* Fruhstorfer [type locality Waigeo (Waigiu)] and, while he mentioned the presence of this taxon across New Guinea, he made no mention of any localities east of New Guinea other than Ulawa in the Solomon Islands. Parsons (1998: p. 288) further stated 'It also appears that the taxon *walkeri* Butler ... might belong to *umbratica*.' Certainly, *E. walkeri* and *E. umbratica* appear similar, but some caution is necessary. The forewing apex is well rounded in New Guinea examples [*E. sada*] but subtly pointed in *E. walkeri*; New Guinea examples also have a more convex forewing termen. Solomon Islands examples [typical *E. umbratica*] have more extensive black forewing areas than *E. walkeri*.

E. umbratica is widespread in the Solomon Islands (Tennent 2002) but the placing of it, *E. sada* and *E. walkeri* in synonymy needs further support. *E. walkeri* has priority over *E. sada* but, at least for the time being, all three taxa should be regarded as distinct.

Elodina hypatia hypatia

When black and white prints of a few specimens of *E. h. hypatia* C. & R. Felder photographed under ultraviolet light were examined, one male from Sambio, Morobe Province, Papua New Guinea, appeared quite distinct. On the upperside of the wings this specimen was white in colour, apart from the apical areas, whereas other specimens examined had blackened upper surfaces. However, under visible light this specimen appeared typical for *E. h. hypatia*, except perhaps for a sinuous dark subapical patch on the forewing underside. The possibility exists that two species are involved.

Elodina egnatia

E. egnatia (Godart) occurs in the Moluccas, Sulawesi and Timor region (see Table 1). Waterhouse and Lyell (1914) included *E. angulipennis* under *E. egnatia* because a series of larger specimens from Prince of Wales I., Torres Strait, Queensland, appeared to be nearer typical *E. egnatia* than those from the mainland. However, *E. angulipennis* was returned to species status by Talbot (1932-1935) and Common and Waterhouse (1972). There are some similarities within the group, which includes *E. egnatia, E. angulipennis* and *E. queenslandica,* but the females of *E. egnatia* have hindwings washed in a cream colour on their undersides (not so for *E. angulipennis* and *E. queenslandica*). The apex of the forewing in *E. egnatia* is more acute than in *E. queenslandica* and slightly so in *E. angulipennis.* There is a large distributional gap between *E. queenslandica* (to which Waterhouse and Lyell (1914) were referring above) in the Torres Strait and the nearest *E. egnatia* population (Timor, Ambon or Ceram). It would be interesting not only to compare these three taxa but also the six subspecies of *E. egnatia*, which are widely separated geographically, using molecular techniques. Such a study might extend the species list even further.

Conclusion

Our taxonomic understanding of *Elodina* is still incomplete but, as with any difficult and cryptic group, caution is needed before any taxa are arbitrarily sunk or synonymised. The use of molecular systematics, including DNA analysis, may be necessary to resolve the problems of the group and either support or alter the present arrangement. On present evidence, the arrangement presented in Table 1 appears the most sound.

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